

What is Radioactive Decay?

General Public

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Fact Sheet #8B

Environmental Health Programs
Office of Radiation Protection



RADIOACTIVE DECAY

The atomic structure for certain atoms is unstable; these unstable atoms are termed radioactive atoms or radionuclides. Radioactivity is the natural and spontaneous process by which radionuclides transform or decay to a different state, and emit or radiate excess energy in the form of particles or waves called radiation. Depending on how the radionuclide releases this excess energy, either a lower energy atom of the same form results, or a completely different atom will be formed.

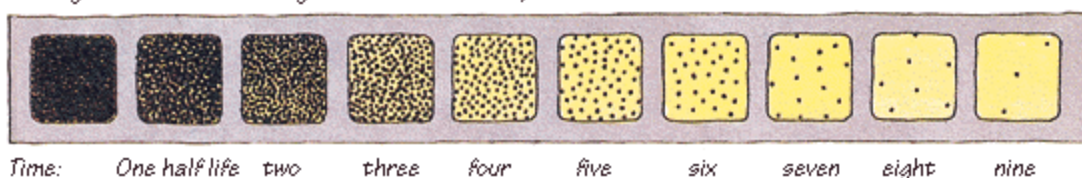
Radionuclides decay in a random fashion, but at a characteristic rate. The length of time this takes, the number of steps required and the kinds of radiation released at each step are well known and are unique to that radionuclide. For instance phosphorus-32, a radionuclide, decays to a stable, or non-radioactive atom of sulfur-32, accompanied by the emission of a beta particle (electron) with energy up to 1.71 million electron-volts (MeV).

HALF-LIFE

The half-life is the time required for the number of radioactive atoms to decrease by one half. After one half-life the number of radioactive atoms is halved, after two half-lives it is reduced to one quarter, after three half-lives to one-eighth and so on.

The activity of any radionuclide is reduced to less than 1% after 7 half-lives.

Decay rate of radioactivity: After ten half lives, the level of radiation is reduced to one thousandth



This half-life is a time that is unique time to each radionuclide. Half-lives can range from less than a millionth of a second to millions of years.

ACTIVITY

The quantity of radioactive atoms present is generally measured in terms of activity rather than number of atoms or mass. Activity is a measurement of the number of radioactive decays, called disintegrations, a given number of radionuclides undergoes in a given period of time. Activity is related to mass, because the greater the mass of radioactive material, the more radioactive atoms are present to undergo radioactive decay.

The two most common units of activity are the Curie or the Becquerel (international units).

- ◆ 1 Curie (Ci) = 3.7×10^{10} disintegrations per second (dps)
- ◆ 1 Becquerel (Bq) = 1 disintegration per second (dps)
- ◆ 1 Millicurie (mCi) = 1/1,000 (one thousandth) of a curie
- ◆ 1 Microcurie (μ Ci) = 1/1,000,000 (one millionth) of a curie
- ◆ 1 Nanocurie (nCi) = 1/1,000,000,000 (one billionth) of a curie
- ◆ 1 Picocurie (pCi) = 1/1,000,000,000,000 (one trillionth) of a curie

A picocurie is one trillionth of a curie. To put the relative size of one trillionth into perspective, consider that if the Earth were reduced to one trillionth of its diameter, the “picoEarth” would be smaller in diameter than a speck of dust. In fact, it would be six times smaller than the thickness of a human hair.

Sources

Princeton University, <http://www.princeton.edu/~ehs/radtrain/Modules/basics.html>

Michigan State University,

<http://www.pa.msu.edu/courses/1997spring/PHY232/lectures/radioactive/half-life.html>

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